IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:
Thackeray *et al.*

Serial No.: 08/206,792

Filed: April 1, 1994

For: ELECTROCHEMICAL CELL

Group Art Unit: 1111

Examiner: M. Nuzzolillo

Atty. Dkt. No.: ADAA:105/MBW

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September 4, 2001 Mark B. Wilson
Date

REPLY BRIEF TO SUPPLEMENTAL EXAMINER'S ANSWER

BOX AF
Commissioner for Patents
Washington, DC 20231

Sir:

This is in reply to the Supplemental Examiner's Answer ("Answer") mailed on July 16, 2001, regarding the above-captioned application. Under 37 C.F.R. § 1/193(b)(1) this reply is due on September 16, 2001. No fees are believed due in connection with this filing. Should any other fees be due, Appellants authorize the Commissioner to debit Fulbright & Jaworski Account No. 50-1212/10002131/MBW.

I. GROUNDS FOR REPLY

This reply is proper as it addresses only grounds of rejection presented in the Supplemental Examiner's Answer. Appellants respectfully request consideration of these comments by the Board prior to rendering of a decision on this appeal.

II. STATUS OF CLAIMS AND AMENDMENTS

The Supplemental Examiner's Answer indicates that the statement of the status of the claims and the after final amendments contained in the brief are correct. Therefore, claims 1 and 3-20 are the subject of this appeal. A copy of the currently appealed claims is attached hereto as Appendix A.

III. RESPONSE TO SUPPLEMENTAL EXAMINER'S ANSWER

A) The Supplemental Examiner's Answer reiterates the rejection of claims 1, 3-4, 7-15, and 18-20 over Thackeray *et al.* 4,507,371 (the '371 patent). See page 6 of the Answer. Appellants reiterate their response to this rejection as set forth in the Appellant's Appeal Brief, Reply Brief, and in the arguments of record in the case.

B) The Supplemental Examiner's Answer rejects all pending claims as being unpatentable over Thackeray *et al.* 4,507,371 (the '371 patent) in view of Thackeray *et al.* 5,316,877 (the '877 patent).[1] See page 7 of the Answer.

Appellants respectfully note that although the claims are rejected over the '371 patent in view of the '877 patent, the Answer does not cite or discuss the '877 patent in its argument. The citation of the '877 patent in the rejection indicates that the '877 discloses an element of the

Examiner's *prima facie* case of obviousness over the '371 patent. However, the absence of any disclosure or discussion of the '877 from the Answer's argument reveals that, despite the apparent need for the disclosure of the '877 in the present *prima facie* case, the argument for rejection rests solely upon the '371. Appellants note that the inclusion of '877 for the Answer's *prima facie* case in this rejection supports Appellants' arguments that the present invention is patentable over the '371 alone.

In any event, Appellants argue that the present invention is patentable over either the '371 patent alone or in view of the '877 patent. In particular, neither the '371 patent, nor the '371 in view of the '877 patent discloses or suggests the combination of individual elements of the present invention.

The '371 patent is said to disclose a spinel lithium manganese dioxide with stabilizing cations. According to the Answer, the anode and cathode may be made with the spinel material and the electrolyte may contain a lithium salt and a solvent. The Answer further concludes that the '371 cell is a rocking chair cell based on its alleged teaching that M cations are released from the anode into the electrolyte during discharge of the cell. The Answer takes the position that where the cathode has the spinel formula, the M cations would enter the cathode from the electrolyte, but points to no specific portion of the patent suggesting this particular arrangement. The Answer admits that the '371 patent differs from the claimed invention in the spinel structure compound.

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[1] Appellants infer that the Answer's citation to "Thackeray 5,316,8" refers to Thackeray *et al.* 5,316,877.

While it may be true that the individual elements of the present invention were known, their combination was not known prior to the present invention. It is clear that the invention must be considered *as a whole*. *Gillette Co. v. S.C. Johnson & Son, Inc.*, 919 F.2d 720, 724 (Fed. Cir. 1990). The present invention as a whole includes a particular anode, a particular cathode and a particular electrolyte. Although each element was individually known, and may be contained in the cited references, to be obvious, their combination must be taught or suggested *in the cited references*. *In re Vaeck*, 947 F.2d 488, 493, 20 U.S.P.Q.2d 1438 (Fed. Cir. 1991). Significantly, the suggestion of their combination is not found in either of the cited references.

As discussed in previous responses, the '371 patent deals generally with electrochemical cells having an anode and a cathode coupled by a solid electrolyte, with each of the anode, cathode and electrolyte comprising a cubic close-packed framework structure having, as its base structural unit, a unit of the formula $(B_2)X_4^{n-1}$, where $(B_2)X_4$ is the structural unit of an $A(B_2)X_4$ spinel. The '371 patent does not teach a cell having a solid lithium transition metal oxide spinel compound as an anode, a lithium metal oxide compound which may be a spinel as a cathode, and a lithium containing liquid or polymer as an electrolyte, so that the cell operates in a "rocking chair" fashion.

The basic concept in the '371 patent is exemplified by a single example illustrating a $Li_{1+x}(Mn_2)O_4$ system to demonstrate the basic concept of using a stable $(B_2)X_4$ framework of an $A(B_2)X_4$ spinel as a host structure for anodes, cathodes and electrolytes in rechargeable lithium batteries. Unlike the cell of the invention, the cell of the '371 patent is an all solid state cell. Moreover, as the Answer acknowledges, the '371 cell lacks a teaching of the spinel structure compound.

The '877 patent teaches spinel compounds $Li_2Mn_4O_9$ and $Li_4Mn_5O_{12}$. However, the '877 patent does not teach or suggest that these materials can be used in a lithium-ion or rocking chair cell such as that of the invention. Thus, like the '371 cell, the '877 cell would not have the advantages of the cell of the invention as described at page 18, lines 10-15 of the specification. Furthermore, the '877 patent deals in detail with the cathode of an electrochemical cell and deals only in broad outline with the other components of the cell, particularly the anode and the electrolyte. The '877 patent lacks a teaching, either expressly or implicitly, that the anode may be a lithium transition metal oxide spinel compound as claimed in the present application.

A major advantage of the rocking chair cells of the invention is that they are significantly safer than known lithium-ion cells that use lithium-carbon, or lithium alloy, anodes, such as $Li_xC/LiCoO_2$ lithium-ion cells which have carbonaceous anodes and $LiCoO_2$ cathodes. The known lithium-carbon, or lithium alloy, anodes provide voltages close to that of metallic lithium, particularly at the top of charge. In contrast, the anodes of the present invention provide voltages much further away from that of metallic lithium, rendering them inherently much safer anode materials in lithium-ion cells than those used in the known or state of the art lithium-ion cells. For example, a lithium-ion oxide spinel anode in a lithium-ion cell of the invention operates at about 0.8V away from metallic lithium, a lithium-titanium-oxide spinel at about 1.5V away from metallic lithium, and a lithium-manganese oxide spinel at about 3.0 V away from metallic lithium. *See* specification page 18, lines 10-15.

It is well settled patent law that "obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some *teaching, suggestion, or motivation* to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art." *In re Fine*, 837 F.2d 1071, 5

U.S.P.Q.2d 1596 (Fed. Cir. 1988) (emphasis added); *In re Jones*, 958 F.2d 347, 21 U.S.P.Q.2d 1941 (Fed. Cir. 1992); *see also* MPEP § 2143.01.

Furthermore, the fact that a reference or references can be combined or modified is not sufficient to establish obviousness. For example, the Federal Circuit held in *In re Mills*, 916 F.2d 680, 16 U.S.P.Q.2d 1430 (Fed. Cir. 1990), that the mere fact that combination or modification of a reference or references is possible does not establish obviousness of the resultant combination *unless the prior art also suggests* the desirability of the combination, *i.e.*, unless the prior art provides *motivation* to produce the resultant combination. *Mills*, 16 U.S.P.Q.2d at 1432; *see also* MPEP § 2143.01, page 2100-91.

Moreover, the Board of Patent Appeals and Interferences has held that the fact that the claimed invention is within the capabilities of one of ordinary skill in the art is not sufficient by itself to establish obviousness. *Ex parte Levengood*, 28 U.S.P.Q.2d 1300 (BPAI 1993). Section 2143.01 of the MPEP explains the *Levengood* holding as follows:

> A statement that modifications of the prior art to meet the claimed invention would have been "'well within the ordinary skill of the art at the time the claimed invention was made'" because the references relied upon teach that all aspects of the claimed invention were individually known in the art is not sufficient to establish a *prima facie* case of obviousness without some objective reason to combine the teachings of the references.

MPEP § 2143.01, page 2100-91 (emphasis in original).

Additionally, the consistent criteria for determination of obviousness is whether the prior art would have suggested to one of ordinary skill in the art that this process should be carried out and would have a reasonable likelihood of success, viewed in the light of the prior art. Both the suggestion and the expectation of success must be found in the prior art, not in the applicant's disclosure.

Appellants respectfully point out that not one of the references relied on by the Examiner provides a motivation for an electrochemical cell as claimed herein, and particularly as claimed in Claim 1. To establish a *prima facie* case of obviousness, the Examiner must provide logical reasoning or evidence to support his assumption that it would have been obvious to one of ordinary skill in the art to select the anode, cathode and electrolyte to provide a cell which operates in said "rocking chair" fashion. *See e.g., In re Vaeck*, 947 F.2d 488, 493, 20 U.S.P.Q.2d 1438 (Fed. Cir. 1991); MPEP § 2142, 2100-109 (1996). It is submitted that the Examiner has not provided the required reasoning or evidence to properly establish a *prima facie* case of obviousness but merely the bare statements that the '371 patent teaches some elements of the invention but lacks the spinel structures.

There is simply no teaching in either the '371 patent or the '877 patent of the "rocking chair" cell of the present invention. The fact that a skilled artisan has the ability to select materials is clearly not sufficient to establish a *prima facie* case of obviousness. *See Levengood*, 28 U.S.P.Q.2d at 1301-1302; MPEP § 2143.01. The only moving example provided in the '371 patent would not provide the rocking chair cell of the present invention by virtue of the lithium metal anode. In the absence of any teaching in either the '371 patent or the '877 patent of the "rocking chair" mechanism of the invention, it is submitted that no *prima facie* case for obviousness has been made.

As previously pointed out, Claim 1 of the present invention requires a combination of the following features:

(i) As at least part of the anode, a lithium transition metal oxide compound which has a $[B_2]X_4^{n-}$ spinel type framework structure of an $A[B_2]X_4$ spinel, etc.;

(ii) As at least part of the cathode, a (solid) lithium metal oxide compound;

(iii) An electrically insulative lithium containing liquid or polymeric ionically conductive electrolyte between the anode and the cathode;

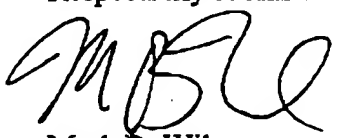
(iv) The anode, cathode and electrolyte being such that the mechanism of the cell exhibits a "rocking chair" effect, wherein on discharge, lithium ions are extracted from the spinel type framework structure of the anode, with the oxidation state of the metal ions of the anode thereby increasing, while a concomitant insertion of lithium ions into the compound of the cathode takes place, with the oxidation state of the metal ions of the cathode decreasing correspondingly.

In this regard, see also page 18, lines 5 to 9 of the specification. Clearly, neither the '371 patent nor the '877 patent at all teaches the combination of features (i), (ii), (iii) and (iv) of Claim 1 as set out above. Therefore, it is respectfully requested that the rejections be overturned by the Board.

IV. CONCLUSION

In light of the foregoing, it is respectfully submitted that all claims are in condition for allowance and Appellants respectfully request that the Board overturn all remaining grounds for rejection. Should any questions arise as a result of this reply, Appellants invite the Examiner or the Board to contact the undersigned at the telephone number listed below.

Respectfully submitted,



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Date September 4, 2001

APPENDIX A

1. An electrochemical cell, which comprises

as at least part of an anode, a lithium transition metal oxide compound which has a $[B_2]X_4^{n-}$ spinel-type framework structure of an $A[B_2]X_4$ spinel wherein A and B comprise metal cations selected from the group consisting of Li, Ti, V, Mn, Fe and Co with the proviso that at least one of A and B comprises Li and at least one of A and B comprises Ti, V, Mn, Fe and/or Co, X is oxygen (O), and n- refers to the overall charge of the structural unit $[B_2]X_4$ of the framework structure, and the transition metal cation of which in the fully discharged state of the cell has a mean oxidation state greater than +3 for Ti, +3 for V, +3.5 for Mn, +2 for Fe and +2 for Co;

as at least part of a cathode, a lithium metal oxide compound; and

an electrically insulative, lithium containing, liquid or polymeric, ionically conductive electrolyte between the anode and the cathode, such that, on discharging the cell, lithium ions are extracted from the spinel-type framework structure of the anode, with the oxidation state of the metal ions of the anode thereby increasing, while a concomitant insertion of lithium ions into the compound of the cathode takes place, with the oxidation state of the metal ions of the cathode decreasing correspondingly.

3. A cell according to Claim 1 wherein, in the compound of the anode, B is a single transition metal cation.

4. A cell according to Claim 1 wherein, in the compound of the anode, B is a mixture of different transition metal cations.

5. A cell according to Claim 1, wherein the compound of the anode is a stoichiometric spinel selected from the group consisting of $Li_4Mn_5O_{12}$, which can be written as $(Li)_{8a}[Li_{0,33}Mn_{1,67}]_{16d}O_4$ in ideal spinel notation; $Li_4Ti_5O_{12}$, which can be written as $(Li)_{8a}[Li_{0,33}Ti_{1,67}]_{16d}O_4$ in ideal spinel notation; $LiTi_2O_4$ which can be written as $(Li)_{8a}[Ti_2]_{16d}O_4$ in ideal spinel notation; LiV_2O_4, which can be written as $(Li)_{8a}[V_2]_{16d}O_4$ in spinel notation; and $LiFe_5O_8$, which can be written as $(Fe)_{8a}[Fe_{1,5}Li_{0,5}]_{16d}O_4$ in ideal spinel notation.

6. A cell according to Claim 1, wherein the compound of the anode is a defect spinel selected from the group consisting of $Li_2Mn_4O_9$, which can be written as $(Li_{0,89}\square_{0,11})_{8a}[Mn_{1,78}\square_{0,22}]_{16d}O_4$ in spinel notation; and $Li_2Ti_3O_7$, which can be written as $(Li_{0,85}\square_{0,15})_{8a}[Ti_{1,71}Li_{0,29}]_{16d}O_4$ in spinel notation.

7. A cell according to Claim 1, wherein the compound of the anode is a lithium-iron-titanium oxide having a spinel-type structure and in which A comprises lithium and iron cations, while B comprises lithium, iron and titanium cations.

8. A cell according to Claim 1 wherein, in the compound of the anode, the $[B_2]X_4$ framework structure contains, within the framework structure or within interstitial spaces present in the framework structure, additional metal cations to the lithium ions and the other A and B cations to stabilize the structure, with the additional metal cations being present in an amount less than 10 atomic percent.

9. A cell according to Claim 1, wherein the lithium metal oxide compound of the cathode also has a spinel-type framework structure.

10. A cell according to Claim 9, wherein the framework structure of the lithium metal oxide compound of the cathode has as its basic structural unit, a unit of the formula $[B_2]X_4^{n-}$,

wherein $[B_2]X_4^{n-}$ is the structural unit of an $A[B_2]X_4$ spinel, with the X anions being arranged to form a negatively charged anion array, and wherein

A comprises a lithium cation;

B comprises at least one metal cation;

X is oxygen (O); and

n- refers to the overall charge of the structural unit $[B_2]X_4$ of the framework structure, with the transition metal cations of the anode being more electropositive than those of the cathode.

11. A cell according to Claim 10 wherein, in the compound of the cathode, B is a single metal cation.

12. A cell according to Claim 10 wherein, in the compound of the cathode, B is a mixture of different metal cations.

13. A cell according to Claim 10, wherein the compound of the cathode is a spinel in which the B cation is selected from the group consisting of Li, Mn, Co and Ni.

14. A cell according to Claim 10 wherein, in the compound of the cathode, the $[B_2]X_4$ framework structure contains, within the framework structure or within interstitial spaces present in the framework structure, additional metal cations to the lithium ions and the other A and B cations to stabilize the structure, with the additional metal cations being present in an amount less than 10 atomic percent.

15. A cell according to Claim 14, wherein the compound of the cathode is $Li_{1+\delta}Mn_{2-\delta}O_4$ where $0< \delta \leq [0,1]0.1$.

16. A cell according to Claim 14, wherein the compound of the cathode is $LiM_{\delta/2}Mn_{2-\delta}O_4$ where M=Mg or Zn and $0< \delta\leq[0,05]0.05$.

17. A cell according to Claim 1, wherein the lithium metal oxide compound of the cathode has a layered structure conforming to the formula $Li_xCo_{1-y}Ni_yO_2$ where $0< x\leq 1$ and $0\leq y\leq 1$.

18. A cell according to Claim 1, wherein the anode compound offers a voltage of 3V or less against pure lithium, while the cathode compound offers a voltage of between 3V and 4.5V against pure lithium.

19. A cell according to Claim 1, wherein the electrolyte is a room temperature electrolyte selected from the group consisting of $LiClO_4$, $LiBF_4$, and $LiPF_6$ dissolved in an organic solvent selected from the group consisting of propylene carbonate, ethylene carbonate, dimethyl carbonate, dimethoxyethane and mixtures thereof.

20. A cell according to Claim 1, wherein the electrolyte is a polymeric electrolyte selected from the group consisting of polyethylene oxide (PEO) - $LiClO_4$, PEO - $LiSO_3CF_3$ and PEO - $LiN(CF_3SO_2)_2$.